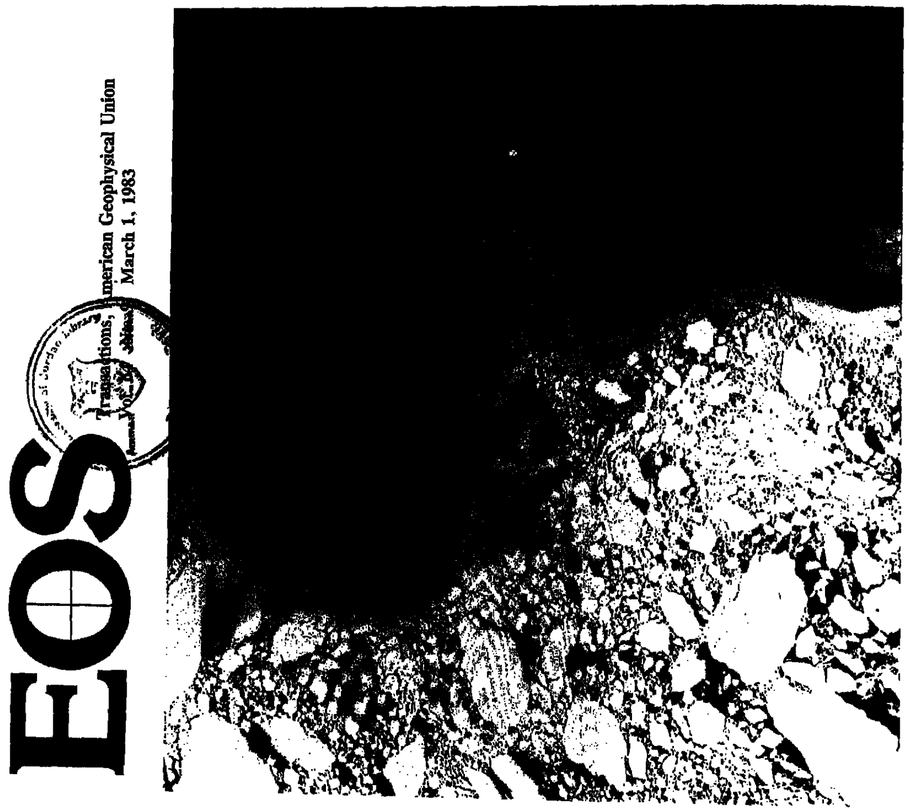

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The Oceanography Report, page 82

The Role of Science In the Public Arena

Arthur B. Weissman
AGU Congressional Science Fellow

The AGU Congressional Science Fellowship offers scientists a very special opportunity to become directly involved in public policy making at the federal level. As this year's AGU Congressional Science Fellow, I have been working for Senator Christopher J. Dodd (D-Conn.) as his legislative assistant for environment and energy matters. I would like to describe some of my impressions so far regarding the role of science in public policy.

My sudden transition from academic science to the political arena highlighted for me the differences between the two, which are striking and at times disconcerting. Academic scientists, laden with teaching and often administrative responsibilities, are fond of complaining of the lack of time for creative research and thinking. But, for the most part, they are in an environment which supports and encourages research and independent thinking. In the political world such words as 'professor' and 'research' can be pejorative or, at best, quaint; professors and research reports may be taken seriously only when they support a given political viewpoint.

On the other hand, the political complaint about 'two-handed' scientists suggests with some justification that scientists are often not 'up front' about the meaning and significance of their work. It is not just that scientists play on ambiguity and often refuse to take sides in controversial issues; politicians of course do this too (and more capably). But because they are not often required to justify their work, as politicians are, scientists are not always as conscientious in pulling their work together and explaining its purposes clearly in their writings.

Despite these obvious differences, there is a parallel between scientific and political positions in the way factual information is used, and this can be useful in understanding the role of science in public policy. A scientific position (conclusion, finding, or theory) is developed from a set of facts about natural phenomena; but, particularly when a position is controversial or preliminary, the facts used to support it are selected among a much larger array of facts and related phenomena, not all of which necessarily support that position. (Of course, a reasonable position must not be strongly contradicted.) In a similar way, political positions are developed, justified, and defended on the basis of a certain set of facts. Those who hold opposite positions appeal to another set of facts, often complementary to the first. It is the selection and combination of facts that, as in a scientific position, make the case for a political viewpoint.

Now, the role of science in the formulation of public policy is somewhat analogous to the role of facts in either scientific or political positions. The purely scientific aspects of an issue are one step removed from the political process; the *results* of scientific inquiry, however, play much the same role as any other kind of fact. A scientist's interpretation of a complicated technological or scientific issue of public significance, such as nuclear waste disposal or acid precipitation, becomes a factual 'finding' on which to base a certain political position. Conflicting scientific interpretations can be used by different sides to support conflicting political positions. Hence, each side may have its 'darling' scientist, and a Congressional hearing may seem to support a particular political position. The subordinate role of science per se also helps explain why politicians are impatient with the complex reasoning and factual documentation that lead up to a scientific conclusion, since it is only the latter which has any direct usefulness in the political process. The practice of science, then, is one step removed from public policy, but its results are directly linked as 'factual' evidence.

This formulation may appear to diminish the role that science can play in determining public policy, but I think that it accurately reflects the distinction that must be drawn between science and policy making. Although science inevitably incorporates certain values, science alone can never determine how our society decides among competing or conflicting needs and goals. These can be determined only by social and political priorities. Science can, however, play a role in ensuring that decisions are made with a clear understanding of the problem and its possible consequences and likely solutions.

The challenge for a scientist in the public arena is to be faithful to both ends of the decision process, scientific and political. One must first get an accurate scientific picture of a problem, using the best scientific judgment in the selection and consideration of facts. Then one must put that scientific picture in the political context and determine what political, economic, and social forces impinge on it. Parts of the picture may emerge more clearly or forcefully and parts may fade from view, but the original scientific picture should not thereby become distorted. Policy will emerge from all of these considerations, and if the politics on which it is based are reasonably wholesome, none of the 'facts' on which it is based should be compromised.

This combination of science and policy is well illustrated in the current issue of acid precipitation. One can easily get immersed in the complexities and uncertainties of the scientific issue in considering reaction rates, catalysts and limiting factors, transport from source to receptor, and effects on soils, lakes, and biota. Although many of the critical links in acid precipitation are not yet scientifically established, the overall picture—the trend—is apparent to some extent, and both the public and its public servants are demanding 'facts' from scientists to justify either a program of control or a policy of delay. It is clear, however, that scientific certainty alone can not determine a decision on acid precipitation control, for that is ultimately a political choice among values: ecological and possible health effects compete with economic costs and social disruption. The scientific aspect of the issue concerns what, where, and how much to control; but the decision of whether or not to control acid precipitation and to what degree is ultimately political.

Thus, a Congressional Fellow must extend the comfortable universe of scientific knowledge into a somewhat alien realm where it must compete with other considerations on a more or less equal basis. Congress is, after all, like a vast marketplace, and politics at its best is the making of choices among the 'common wealth.' Certainly only by understanding, and not ignoring, the political process can scientists hope to see public policies made in accordance with good scientific thinking.

Arthur B. Weissman *is AGU's sixth Congressional Fellow. He received his Ph.D. last year from the Johns Hopkins University Department of Geography and Environmental Engineering for his dissertation on the aesthetics and geomorphology of environmental change. He received his A.B. from Harvard College in 1970 and an M.F.S. degree in natural resource management from Yale University's School of Forestry and Environmental Studies in 1975. From 1975 to 1977 he was Assistant Director of the Nature Conservancy's Connecticut chapter. He has conducted research at the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, and the U.S. Forest Service, and has held teaching positions at the Leysin American School in Leysin, Switzerland, at Maryland's Towson State University, and at Johns Hopkins University.*

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Interested candidates should submit a letter of intent, a curriculum vitae, and three letters of recommendation to AGU. For further details, write or call Member Programs Division, Congressional Fellowship Program, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20009 (telephone: 462-6903 or 800-424-2488 outside the Washington, D.C. area).

Deadline: March 31, 1983

News

Mn Solubility Tested in Seawater

It has been known for the past 2 or 3 years that the concentration of manganese in the upper several hundred meters of ocean water is unlike that of other trace metals such as copper, zinc, cadmium, and nickel. Trace metals are needed as a sort of 'vitamin supplement' by marine plants and animals; the surface supply is biologically scavenged and regenerated at depth. Thus ocean concentrations of trace metals increase with depth.

Manganese, by contrast, appears to be concentrated in the photic zone and becomes relatively depleted in the depth interval 50–100 m from the surface. W. Landing and K. Bruland (*Ear. Planet. Sci. Lett. 49*, 45–56, 1980) described their observations of vertical distributions of manganese in a study of samples from the north Pacific. Recently, W. Sunda, S. A. Huntsman, and A. Harvey, in a study supported by the National Oceanic and Atmospheric Administration have found similar behavior of manganese in samples of coastal seawater and offshore seawater collected off North Carolina (*Nature, 20,* January 1983). They suggest on the basis of experiments conducted with these samples that the marine biological community itself serves to condition the surface seawater and, with the assistance of photoreduction, cause manganese to dissolve in the otherwise oxygenated zones.

It is believed that manganese arrives in surface ocean seawater by way of river or wind transport as MnO_2. Water upwelled from great depth usually is deficient in manganese, and manganese from submarine hot spring sources apparently does not contribute to the surface manganese profile, according to Landing and Bruland. Sunda et al. point out that the Mn^{IV+} ion, as MnO_2, is insoluble and, to be sufficiently soluble to explain the observations, must be chemically reduced to Mn^{2+} or strongly oxidized to the permanganate ion MnO_4^-. As MnO_2, the manganese would be lost from the water column by sinking. Because permanganate production is highly unlikely, it seems logical that a process exists in the ocean, even in oxic surface water, that reduces manganese to the divalent state. The Mn^{2+} ion is highly soluble.

Sunda et al. collected their seawater samples off the North Carolina coast at two stations. One was near the mouth of the Newport River Estuary and the other was out in the Gulf Stream. They also extracted some marine humic acid from seawater collected at a depth of 5 m from a station located 110 km south of Cape San Blas, Florida. The idea was to treat the North Carolina water with natural humic acid, which is a reasonably strong reducing agent.

It was found by a series of experiments and subsequent analysis of dissolved manganese that humic acids greatly enhance the solubility of manganese oxide in seawater. In other experiments they demonstrated that humic and fulvic acids in river water also cause manganese oxide to dissolve. The process was observed to be strongly stimulated by sunlight, and thus it was concluded that the dissolution is the result of a photoactivated process.

The process in the oceans would be similar. At the ocean surface there is an abundance of sunlight and of organic matter that itself has developed under the influence of photosynthetic processes. The conditions appear to be favorable for the photoactivated reduction of manganese by dissolved organic matter. Manganese in this state would be dissolved, explaining observed marine profiles. The amount of sunlight and the content of dissolved organic matter decreases with depth in the ocean, so this would explain the decrease in manganese concentration. It is observed that there is an increase in particulate MnO_2 concentration near the bottom of the photic zone. Such particles would sink eventually.

Landing and Bruland arrived at much the same conclusion about the source of the manganese. In their analyses of surface water manganese, they also measured the ^{210}Pb concentrations. They found, however, that the Mn cycle of deposition to the ocean surface and later removal from the water by scavenging is not generally coupled with the ^{210}Pb cycle, whose surface distribution is characterized by its atmospheric input. They concluded that unlike ^{210}Pb, most surface manganese is derived from rivers, estuaries, and near-surface shelf sediments. They note as well that manganese concentrations follow reduction zones in the oceans, corresponding to the oxygen minimum zones.

At the surface, though, oxygen is not at a minimum, and Sunda et al. think that the process they postulate not only is responsible for the geochemical concentrations of manganese at the surface but, in circular, is an important biological process. Deep seawater that is upwelled contains insufficient manganese to support maximum plant growth, they note. The photoactivated process in the photic zone would retain manganese and thus help to maintain a supply of the dietary needs of phytoplankton. The process is thus believed to facilitate maximum primary productivity in the sea.—*PMB*

Guth Theory Uses Higgs Monopoles

If magnetic monopoles exist at all, they may originate from a type of quantum mechanical field called a Higgs field. Higgs fields are an essential part of certain of the grand unified theories of physics, GUTs. It is nice that the so-called GUT theories can accommodate the production of monopoles in the formational processes of the universe. It is also nice that the GUT theories of particle physics can accommodate the origin of the universe at all. In a report of December's Eleventh Texas Symposium on Relativistic Astrophysics (*Science*, January 28, 1983), a paper by A. H. Guth of the Massachusetts Institute of Technology describes a new version of the 'Big Bang–Big Crunch' theory of the origin of the universe. Guth's theoretical model explains a number of questions raised previously about the Big Bang expansion and, in so doing, addresses the monopole question.

As described in the *Science* report, Guth's theory uses the concept that the quantum Higgs fields can tie themselves into a knot, thus forming a heavy particle with single magnetic polarity—a monopole—having an equal chance to be of north or south character. By contrast, all known magnetic fields are directly or indirectly electromagnetic in origin and have the property that even when broken, the resulting magnetic parts are dipolar.

There are problems with producing the universe by a Big Bang, some of which involve monopoles. If monopoles can be formed, they would have done so in abundance. Monopoles should be as common in the universe as protons. Monopoles predictably would act as sort of 'antigravitation' devices, and they would, if so abundant, at least have wiped out the galactic magnetic field. Further, the mass excess in our universe due to the monopoles would be huge, enough to have caused the universe to have collapsed back to its point of origin—that is, the Big Crunch idea. The Big Crunch has not oc-

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curred, and monopoles are not too common, although one may have been observed (see *Eos*, February 22, 1983). Instead, the density of the universe is in critical balance between Big Crunch and infinite expansion. The remarkably precise, symmetrical, and uniform nature of essentially all of the properties of the universe seem to defy theoretical logic. To explain all these unusual phenomena, and to do so within GUTs, Guth invoked an 'inflationary scenario,' an exceedingly rapid expansion stage within the very first part of the Big Bang.

As argued by Guth, 'For the real universe to be so close to criticality now, some 10 billion to 20 billion years after the Big Bang, it must have differed from criticality in the earliest instants by less than one part in 10^{49}. An initial condition cries out for an explanation.' The explanation fell out of a sort of quantum phase diagram approach. In a particle physics analogy to a crystallization sequence, the whole universe undergoes a series of phase transitions. The Higgs held 'freezes out' in this model and in a way forms a field of lattice points that affects quantum particles and their mutual interactions. The way the Higgs held freezes in those models is rather important, the results producing a range of possible structures from a sponge-like character to that of a congealed mass of jelly. The 'jelly' model yields the best results. In its scenario, the universe begins at a point source whose diameter is one trillionth that of a proton. The inflation begins, therefore, from a system small enough to have achieved thermal equilibrium. The inflation undergoes a smoothing-out process resulting in a uniform universe. The monopoles, or most of them, were lost in the phase transition stage that changed undifferentiated elementary particles such as quarks, leptons, and neutrinos into composites such as protons, neutrons, or mesons. Electrons and neutrinos stayed in the free state as they are observed now.—*PMB*

Study Finds Carbon Mobility in Olivine

The significance of carbon's existence as a solid solution in olivine is many fold. Currently there are speculations about the contributions of dissolved carbon to the electrical conductivity of minerals that constitute the earth's upper mantle, and for this contribution olivine is a prime candidate. If carbon, once dissolved, is relatively mobile in upper mantle mineral structures, a lot can be speculated about diffusional processes in the upper mantle, the very diffusional processes many geophysicists ordinarily assume to be relatively unimportant. Diffusion—creepy processes that support convective overturn in the solid-state—can be accelerated, perhaps, by the mobility of minor elements.

In their recent study of carbon in natural olivine, G. Oberheuser, H. Kathrein, G. Demortier, H. Gonska, and F. Freund of the University of Köln, West Germany, found that the carbon in olivine exists in a truly dissolved state, not as carbon dioxide related anionic groups or as a graphite-like polymer (*Geoch. Cosmoch. Acta*, in press, 1983). They found that the dissolved carbon has a relatively high diffusion rate which is, needless to say, unexpected for an olivine host. Their study showed that the carbon was not associated with major lattice defects such as dislocations or subgrain boundaries. The carbon apparently is bonded with the olivine with an approximate $C\text{-}O^-$ character.

Oberheuser et al. used two specialized methods to study the carbon. They analyzed the carbon by means of observing the nuclear reaction $^{12}C(d,p)\,^{13}C$, and also by the X ray induced photoelectron spectroscopy (XPS) technique. Carbon analysis by nuclear reaction is a rather novel approach, described by Oberheuser et al. as being 'a powerful method and certainly of interest to many petrologists.' The beam of a particle accelerator, deuterium ions in this case, accelerated to an energy lying below the Coulomb barrier, is impinged on the sample. The deuterons convert ^{12}C nuclei to ^{13}C and in so doing lose energy as a function of depth in a process that can yield depth concentration values based on standardization. Due to interferences from other deuteron reactions with light elements, the useful depth range of analysis of carbon in olivine is limited to about 2.5 μm. To observe kinetic, diffusional parameters, the changes of the measured profile were observed from low temperatures (liquid nitrogen) to high temperatures (1050 K).

The XPS or (ESCA) technique used in the olivine study was more or less standard. An X ray beam of $Mg_{K\alpha}$ radiation was made incident onto a specially prepared olivine surface under vacuum. The photoelectrons Cls, Mg2s, Si2p, and Ols, were detected, but because the depth of penetration was only a few Angstroms, it was necessary to sputter away layer after layer to obtain the carbon concentration profiles. An Ar+ ion sputtering device was included in the XPS apparatus.

Total carbon was measured in the olivine crystals by means of an ASTM standard-type carbon analyzer to be on the order of 180 ppm in one specimen and 60 ppm in another. The heating/cooling cycles produced rather sharp profiles of carbon as analyzed by the nuclear reaction and the XPS methods. That the high mobility of carbon observed was due to a thermally activated diffusional process was demonstrated in part by the reversibility. The highly mobile carbon species in these olivines could be made to diffuse to the surface, and then back into the crystal interiors. The driving force for this process was thought to originate in localized lattice strains of carbon atoms in the olivine crystal matrix. Carbon-oxygen bonds would be dipolar. The carbon species would be driven differentially toward elastically relaxed volumes. The diffusion equation was evaluated by substituting the measured values obtained by both techniques as follows. The equation is given by

$$D \text{ carbon (olivine)} = Do \exp(-E/RT)$$

where Do, E, and R are the frequency factor, the activation energy, and the gas constant, respectively. From the nuclear reaction data obtained at $T \leq 300$ K:

$$D = 10^{-12} \exp(-7.8/RT)$$

and from the XPS data obtained 450 K $\leq T \leq$ 925 K:

$$D = 10^{-14} \exp(-6/RT)$$

(both in $m^2\,s^{-1}$ and kJ/mole). The activation energies are unusually low for the case of carbon atoms diffusing through a relatively dense packed crystal structure such as olivines. It would appear that if correct, the data imply a great mobility of carbon in olivine.—*PMB*

Can Tests Identify Creative People?

It is always a popular pursuit by academic administrators to assess the creativity or innovative qualities of scientists in order to evaluate their research capabilities. Of course, traditionally such evaluations have been fraught with subjectivity (i.e., innovative scientists are commonly thought to be weird, under 40 years old, independent, risk-taking, etc.), and thus such evaluations have not been highly valued.

In recent years, through testing, the American Chemical Society (ACS) has attempted to give respectability to the art of predicting the creativity of a scientist. ACS, which draws its members from both industrial and academic laboratories, held a symposium on the subject of evaluating the creativity of scientists. The proceedings were published by ACS as 'Innovation and U.S. Research: Problems and Recommendations' (W. N. Smith and C.F. Larson, eds., 1980). In the proceedings, as reported in the July 1982 *Chemtec* (all quotes here are from the *Chemtec* article), A. Nisson was able to identify only the following two-part characteristic of an innovative person: (1) a low threshold to 'a state of discomfort with some aspect of the order of things, the status quo,' and (2) 'an extraordinarily high level of mental stamina enabling him or her to persist until the state of discomfort is removed.'

W. S. Lyon of Oak Ridge National Laboratory (ORNL) has evaluated the results of new tests and has concluded that, 'a simple, reliable measure of creativity seems to be simply to ask the person.' He qualifies this by pointing out that, 'Such an interrogation most probably should be casually put among other questions, perhaps in written form, so that the respondent does not feel obligated to maintain face by answering "yes."'

Lyon's idea was to compare the results of two creativity tests, which he named after their authors as the 'Davis' and 'Raudsepp' tests. Fifty eight scientists in ORNL's Analytical Chemistry Division took the two tests, 6 months apart. They were also asked to answer four self-evaluation questions and to make peer evaluations. No mention of creativity was made, however. According to Lyon, 'We think it important to emphasize that the questionnaire was not presented as a test of creativity. It is possible that "creativity tests" such as the Raudsepp test automatically sound an alarm in the minds of reasonably intelligent people, an alarm that, try as they may to be objective, will still cause them to pick the obvious "creative" answer.'

Lyon compared the results of the two creativity tests to the self-evaluation questions and the peer evaluations. Lyon found good statistical correlation between the tests and the self-evaluation questions, lending support to the idea that 'most creative people recognize their own creative abilities.' The results also showed good correlation between high creativity scores on the tests and peer judgment, and fair to good correlation between test scores and the number of talks and publications of the scientists questioned. On the issue of any presumed relationship between creativity and age, Lyon said, 'Essentially, we found no correlation between score (creativity) and age or length of service of respondents.'

The top quartile, the most creative, seemed to be occupied by Ph.D. holders of average age 48 and the bottom quartile, the least creative, by non-Ph.D. scientists of average age 58. The Ph.D. and age factors, if taken separately, show no such correlation, however. Not only does measured creativity have no correlation with age but, as Lyon puts it, 'Creativity, as measured by the test, is no respecter of academic degree.'

The way of testing at ORNL appears to be useful in evaluating the creativity of individuals within groups having very high or very low creativity. The tests did not, however, examine factors that may enhance the creativity of a presumably creative group of people such as scientists.—*PMB*

Geophysicists

William W. Fox, Jr., has been appointed director of the Cooperative Institute for Marine and Atmospheric Studies (CIMAS). He had been director of the Southeast Fisheries Center of the National Marine Fisheries Service since 1978. CIMAS was established in 1977 by the National Oceanic and Atmospheric Administration and the University of Miami.

Seven of the 589 U.S. Fulbright Scholars for 1982–1983 are lecturing and conducting advanced research in geology in universities abroad. ***Brian Francis Farrell***, a research assistant in planetary studies at Harvard University, is lecturing in oceanography at the University of Cambridge in England through June. ***William B. Ferguson***, associate professor of civil engineering at Villanova University, will lecture in geology at the Kangwon National University in Korea until July. ***Ray Edward Ferrell, Jr.***, geology chairman at Louisiana State University in Baton Rouge, lectured and conducted research in marine geology at the University of Oslo in Norway. ***M. Allan Kays***, professor of geology at the University of Oregon in Eugene, will conduct research in geology at the University of Copenhagen in Denmark through April. ***Richard Vernon McGehee***, associate professor of health education at Southeastern Louisiana University (University Station campus), will be lecturing in geology at the University of Monrovia in Liberia through July. ***Bruce Warren Nelson***, a professor of environmental studies at the University of Virginia in Charlottesville, will be lecturing in geology at the Universiti Malaya in Malaysia through April. ***Ronald Porter Willis***, professor of geology at the University of Wisconsin–Eau Claire, will be lecturing in geology at the Seoul National University in Korea through July.

In Memoriam

The following AGU members are recently deceased:

John C. Hagan, 73; AGU Life Member; joined the Meteorology Section (now Atmospheric Sciences) in 1939; died January 17, 1983.

David Kiehn, 31; joined in 1982 as a student member of the Volcanology, Geochemistry, and Petrology Section; died December 11, 1982.

E. J. Workman, 83; AGU Life Fellow; joined the Meteorology Section (now Atmospheric Sciences) in 1942; died December 27, 1982. A scholarship has been established in his name at the New Mexico Institute of Mining and Technology, where he was president and director of the research and development division for 18 years.

Forum

Joint AGU and Lunar Science Conference

For the past 3 years there has been increasing concern about the duplication of papers on lunar and planetary sciences between the meetings of various societies and the annual meeting at the Johnson Space Center, Clear Lake, Texas. In addition to the costs for travel and accommodation (approximately $400–$800 per conference for most attendees from the United States) there is the time spent on airplanes and sitting in sessions. I argue that a potential saving of at least $300,000 per year justifies a reduction of meetings on lunar and planetary sciences. We must find money for young scientists and new ideas.

I propose that the 15th Lunar and Planetary Science Conference (LPSC) be held in association with AGU's 1984 Spring Meeting. Sessions of general interest to all AGU members would be scheduled mainly on Thursday and Friday of the regular AGU session, whereas sessions and workshops of special interest would be scheduled on Saturday and Sunday. The usual short abstract would be submitted for publication in *Eos* by those lunar and planetary scientists who wish to be considered for the sessions of general interest. The AGU program committee would select abstracts for the general session and turn over the specialized abstracts to an LPSC committee for scheduling on Saturday and Sunday. The Lunar and Planetary Science volume of 2-page abstracts could be prepared as usual and distributed only to those who specifically pay an extra registration fee.

Of course there are many considerations which would make it difficult to reach a consensus on the move I am proposing; one in particular would be the fear that the Lunar and Planetary Institute might lose some status and power if the conference moved from Clear Lake. Nevertheless, I believe that this plan offers an opportunity for integrating planetary sciences and meteoritics into a broader cosmochemical and cosmophysical context as well represented by the American Geophysical Union. This should help to strengthen the constituency for planetary sciences and meteoritics, in particular, the current, abysmally poor state of scheduled planetary missions might be improved with a strong push from the entire AGU community. Such a long-term gain would offset any immediate losses that might be apparent to one or more groups of planetary scientists. Furthermore, the planetary scientists could help to strengthen the AGU Spring Meeting. There would be problems but I believe that they can be overcome.

What is your opinion, ladies and gentlemen of the AGU community and particularly of the planetology section? Can you suggest a better alternative?

Joseph V. Smith
University of Chicago

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Cover. The distribution of ionospheric currents at 1220 UT, March 18, 1978, in invariant latitude/magnetic local time coordinates. It has been a long-time dream for geophysicists to infer the distribution of ionospheric currents using geomagnetic data recorded by ground-based magnetometers. This dream has partly come true through the International Magnetosphere Study (IMS), during which six meridian chains of magnetometers were operated and powerful computer codes were developed to analyze the records. As a result of such an international effort, it is now possible to infer instantaneous distribution patterns. For details of the analysis, see Y. Kamide et al., *J. Geophys. Res.*, *87*, 8228–8240, 1982. (Figure courtesy of S.-I. Akasofu, Geophysical Institute, University of Alaska, Fairbanks.)

Books

Cosmic Electrodynamics

J. H. Piddington, 2nd ed., R. E. Krieger Publ., Malabar, Fla., xii + 361 pp., 1982, $27.50.

Reviewed by C. T. Russell

This highly readable monograph is an extensive revision of an earlier book published in 1969 by John Wiley. Piddington clearly loves his subject matter and writes with enthusiasm about the role and critical importance of magnetic fields in the universe around us. He treats solar magnetic fields, the interplanetary medium, the magnetosphere, planetary magnetospheres, and galactic magnetic fields. The treatment is far from uniform, and the topical balance has shifted somewhat from that in the first edition to that in the second. For example, in the first edition there were 27 pages devoted to solar magnetism, and in the second 81 pages. In the first edition there were three chapters devoted to geomagnetism and in the new edition two.

Piddington takes the reader on a whirlwind tour of the cosmos in a more qualitative fashion than quantitative. The author appears to have wanted to document his understanding of the subject and the reasons for his point of view rather than to write a text book. However, with a moderate amount of auxiliary material this book could serve as the focus of a course. Alternate hypotheses are mentioned throughout.

The section on magnetospheric physics, both terrestrial and planetary is quite out-of-date in part because of the explosive growth in our understanding of the magnetosphere of the earth with the ISEE mission, of the solar wind-Venus interaction with the Pioneer Venus mission, and of the magnetospheres of Jupiter and Saturn with the Voyager spacecraft. For example, islands of energetic particles in the tail are mentioned on page 242, whereas we understand such observations today as simply expansions and contractions of the plasma sheet. No mention is made of flux transfer events, inverted V's, conics, vortices, or other important features of the terrestrial magnetosphere. While much is said about flux ropes in the sun, nothing is mentioned about flux ropes in the Venus atmosphere where they have been probed in situ with the Pioneer Venus orbiter. Piddington recognizes this problem in the preface of the first edition where he states, 'A monograph dealing with such a fast developing subject tends to grow out of date.' This statement is still true in 1983 but it is exacerbated by the fact that the book was apparently written in 1977 to judge by the date of the most recent references.

Nevertheless, there is much to recommend this book. It is well written and treats a very broad subject area, often with keen insight. It is recommended reading, especially for those interested in solar magnetism and Piddington's rather unorthodox views.

C. T. Russell is with the Institute of Geophysics and Planetary Physics, University of California, Los Angeles, Calif.

Scientific Basis of Water Resource Management

Geophysics Study Committee, *Stud. in Geophys;* National Academy Press, Washington, D.C., xii + 127 pp., 1982.

Reviewed by H. J. Morel-Seytoux

The least that one can say about the report is that it is very enjoyable reading. Every chapter has been carefully written, and the literary merit of some chapters is outstanding (particularly those by Klemes, 'Empirical and Causal Models in Hydrology,' and by Baker, 'Geology, Determinism, and Risk Assessment'). The best that one can say about the report is that it does meet its stated objectives of (1) evaluation of the adequacy of present hydrologic knowledge and of the appropriateness of present research programs to provide information for decision making and (2) description of the impact of hydrologic knowledge on the planning and management of water resources. The worst that one can say about the report is that it is not particularly original and that there are few really fresh new arguments developed in it. One notable exception is provided in Chapter 11, by Matalas, Landwehr, and Wolman, which challenges the traditional (implicit) assumption that 'human activity is an external perturbation of the hydrologic cycle.' Though not the explicit intent of chapter 4, by Bredehoeft, Papadopulos, and Cooper, with the explosion of the water-budget myth in groundwater, this chapter illustrates clearly the profound interaction of man (through wells) in the hydrologic cycle, a situation that cannot be comprehended from a study of the system free from human influence.

There is a consensus in the report that there is currently much misguided research. 'Much hydrologic research is directed at problems that are not necessarily the most significant ones in theory, on the ground, or in practice' (Leopold, p. 107), or are 'scientifically sterile' (Klemes, p. 99). 'Mathematical convenience is a popular refuge, current fashion running a close second' (Klemes, p. 99). Practically, all authors call for a return to a search for basic understanding of the dynamic mechanisms governing the processes (theory), a return to experimentation (not to be confused with 'the aimless collection of data that sometimes passes for field hydrology' (p. 28)) and the abandonment of computer induced model building, conceptual or statistical, with fruitless evergrowing mathematical sophistications as a research goal in itself. The new focus for research will require 'an uncommon degree of cooperative endeavour from a broad range of the earth sciences' (Eagleson, p. 30) in which water quality will become a predominant concern.

Chapter 1 (Dunne) presents an excellent state of the art for runoff processes. Chapter 2 (Eagleson, 'Hydrology and Climate') is interesting, but not too exciting (though the praise of Eagleson's work in chapter 8 is fully justified). Chapter 3 on the vadose zone (by Nielsen and Biggar) is good, but the authors' recent crush for the stochastic approach may well lead promptly to the blind alleys against which Cassandra warns (in chapter 8 on empirical and causal models by Klemes). Chapter 5 (on water quality by Slever and Stumm) is also good, but the authors seem also tempted by the devil of 'reductionism.' Chapter 6 (on aquatic ecosystems by Cairns) is interesting, but out of place in this report. The philosophy expressed in chapter 7 ('Robust Estimators in Hydrology,' by Fiering and Kuczera) is remarkable, but, most ironically, the authors fall immediately, in their very own chapter, into the pitfalls against which they warned (see the 'model' building on p. 91 and the 'instructive (?)' Figure 7.2). Chapters 9 (Leopold) and 10 (Baker) on hydrology and geomorphology go together. They are to the point and refreshing. What better way is there to denounce the fruitless efforts of developing better plotting position formulae (as an example of futile research) than to take a look at Figure 10.2. Chapter 11 (on prediction) is a surprise. After all, there is no harm, indeed some noblesse, in conceding (even if only implicitly) that one may have been wrong in the past. Only outstanding scientists can afford such turn around and lead again in a new direction.

At the Ph.D. level, and maybe at the M.S. level as well, the report should be required reading for all graduate students (and professors) specializing in hydrology. In a course on Physical Hydrology, as an antidote to brainwashing, Chapters 7 and 11 should be required reading, whereas for Stochastic Hydrology and/or Conceptual Hydrology, the reading list would include the chapters 1, 3, 8 (of course), 9, and 10.

It is a worthwhile report. Read it.

H. J. Morel-Seytoux is with the Ecole des Mines de Paris, Centre d'Informatique Géologique, Fontainebleau, France.

The Mineralogy, Chemistry, and Physics of Tropical Soils With Variable Charge Clays

G. Uehara and G. Gillman, *Westview Trop. Agr. Ser.*, Westview, Boulder, Colo., xviii + 170 pp., 1981, $30.00

Reviewed by D. K. Cassel and D. R. Nielsen

This book is the culmination of an effort started in 1974 when the senior author started assembling information for a tropical soils course that he taught while on sabbatical leave at North Carolina State University. The literature cited throughout the book was current when the book went to press.

Soil systems contain mineral and organic materials that have constant or permanent surface charges, such as montmorillonite, or constant surface potentials, usually referred to as variable charge materials. Most soil systems contain some of both kinds. In the tropics, most of the minerals with permanent charge have been severely weathered. Consequently, the surface charge of the remaining material results from adsorption of potential determining ions. This book treats the mineralogy, chemistry, and physics of the variable charge minerals and soil organic matter.

After a brief introduction, chapter 2, entitled 'Mineralogy,' discusses the relationship between weathering and mineralogy. Mineralogy is currently used to classify soils at the taxonomic family level. The authors go one step further and present a schematic that shows how, in general, the soil orders relate to mineralogy. For example, Vertisols consist primarily of permanently charged smectites, Oxisols consist primarily of oxides and hydrous oxides, and Andisols are composed primarily of noncrystalline materials.

The main emphasis of the book is placed on the chemistry of constant potential surfaces. Chapter 3, entitled 'Chemistry,' combined with chapter 6, entitled 'Analytical Methods,' take up 81 of the 157 pages. The physical chemistry is reviewed for both constant charge and constant potential than a system containing both kinds of clay is discussed. Heavy emphasis is placed on the zero point of charge and how it relates to soil pH. An example explains the theory associated with rejuvenating an acric soil in Brazil by liming (adding divalent Ca and Mg cations to replace monovalent H ions) and adding a heavy application of phosphorus (increases the net negative charge of clay surfaces and increases the retention of cations such as potassium).

The 30 page chapter on physics is disappointing. Nearly all facets of physics are mentioned—rheology, soil water, solute transport, soil temperature, and soil air—but with little depth.

In general, this book summarizes some of the soils consisting predominantly of constant potential materials. The examples that relate agricultural management practices to this chemistry make it worthwhile to read. The book is recommended to provide background information for the student who has little previous knowledge about the theory of constant potential surfaces and for the scientist who is not familiar with differences in chemistry between constant potential and constant surface charge soils.

D. K. Cassel is with the Department of Soil Science, North Carolina State University, Raleigh.

D. R. Nielsen is with the Department of Land, Air and Water Resources, University of California, Davis.

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Replies to ads with box numbers should be addressed to Box ——, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20009.

For further information or to place an ad call toll free 800-424-2488 or 462-6903 in the Washington, D.C. area.

POSITIONS AVAILABLE

Faculty Positions/The University of Iowa. The Department of Physics and Astronomy anticipates one or two openings for tenure-track assistant professors or visiting professors of any rank in August 1983. Preference will be given to experimentalists in any area for the tenure-track positions. Current research interests include astronomy, atomic, condensed matter, elementary particle, laser, nuclear, plasma, and space physics. The positions involve undergraduate and graduate teaching, guidance of research students, and personal research. Interested persons should send a résumé and a statement of research interests, and have three letters of recommendation sent to *Search Committee, Department of Physics and Astronomy, The University of Iowa, Iowa City, IA 52242.*

The University of Iowa is an equal opportunity/affirmative action employer.

Faculty Position in Structural Geology. The Department of Earth and Planetary Sciences at M.I.T. is searching to fill a tenure-track position in structural geology with emphasis on metamorphic regions. Areas of particular interest to us include the relations between metamorphic and structural events, and thermal evolution and structural history in their relation to regional tectonics. Detailed subjects of interest could range from kinematics of metamorphic fabrics and dynamic, kinetic development to larger scale regional tectonics of metamorphic terranes. Applicants with a good background in geochemistry are preferred. A Ph.D. in structural geology and 1–3 years postdoctoral experience are necessary. Individual will be expected to teach undergraduate and graduate level structural geology, and help with annual geology field camp.

Interested applicants should submit curriculum vitae, a brief statement of research interests, selected reprints, and names of four references to:

Dr. William F. Brace, Chairman
Department of Earth and Planetary Sciences
54-918, M.I.T.
Cambridge, MA 02139

M.I.T. is an Affirmative Action/Equal Opportunity Employer.

Position in Petrology/Rice University, Houston, Texas. The Department of Geology has a tenure-track opening beginning July 1983 with starting level of appointment depending on the experience of the candidate. The faculty member is expected to establish, or continue a vigorous research program in petrology and to participate in teaching in mineralogy-petrology. Research areas in which we are potentially interested include: igneous petrology, metamorphic petrology, ore deposition, experimental petrology, interactions of fluids with rocks and sediments, isotope geochemistry, but other specialties are not excluded from consideration. Available research facilities of the Department include: electron-microprobe, ICP-spectrograph, Ar-Ar dating, and stable light isotope mass-spectrometry. Send curriculum vitae, a statement of planned research, and names of at least three references to Dr. A. W. Bally, Chairman, Department of Geology, Rice University, P.O. Box 1892, Houston, Texas 77251.

Rice is an equal opportunity employer.

The University of Western Ontario Department of Geology. The Department of Geology, the University of Western Ontario, London, Canada, invites applications and nominations for a possibly tenured faculty position in the field of mineral deposits. The applicant will be encouraged to do independent research into the genesis of ore deposits and to broaden the scope of this work through collaboration with colleagues in academe and industry. Teaching duties include undergraduate and graduate courses in the geology and mineralogy of ore deposits and graduate student supervision. The appointment is subject to the availability of funds.

The Department has a vigorous and balanced faculty of 15 supported by technical staff and modern equipment. It is within a one day drive of the Noranda, Sudbury, Timmins, and Elliot Lake mining districts and is a two hour drive from Toronto. The Department offers a full undergraduate and graduate program.

A Ph.D. and at least 3 to 6 years direct involvement with field studies of ore deposits are required. Ideally the position is to be filled by July 1, 1983 but date of appointment is negotiable. Rank and salary are dependent on qualifications. Vita and name of three referees should be forwarded by May 1, 1983 to W. S. Fyfe, Chairman, Department of Geology, The University of Western Ontario, London, N6A 5B7.

In accordance with Canadian Immigration requirements, this advertisement is directed to Canadian citizens and permanent residents.

An equal opportunity employer.

Geophysicist. The Air Force Technical Applications Center (AFTAC) is seeking candidates for a staff geophysicist to supervise research in nuclear test detection seismology and hydroacoustics. Duties include in-house research on discrimination between earthquakes and explosions, technical supervision of contractor research and advising management in the candidate's area of expertise. AFTAC is located at Patrick AFB, Florida. Grade level GS-1313–13, salary $34,930. Send a current SF 171 by March 31, 1983 to Huntsville Area Office, Office of Personnel Management, Southerland Bldg., 806 Governors Drive, S.W., Huntsville, AL 35801. For more information, call C. Thirlwell (305) 494-7663. Equal Opportunity Employer.

Naval Postgraduate School. The Department of Oceanography invites applications for the position of Adjunct Research Professor in the Ocean Turbulence Laboratory. The successful applicant will be responsible for the organization and execution of oceanic turbulence measurements as well as the interpretation and reporting of the obtained data. The position requires a Ph.D. or equivalent in Physical Oceanography, 5 years of post-doctoral experience with oceanic measurements and data interpretation, and some familiarity with turbulence instrumentation. The Ocean Turbulence Laboratory is actively engaged in the measurement and interpretation of oceanic turbulence data from a variety of environments obtained with several types of vehicles. The successful candidate will be expected to contribute to the growth and development of the scope of the research performed by the laboratory.

Applicants should send a resume, statement of research record and interests, and the names of at least three references to Prof. Thomas R. Osborn, Code 68Os, Naval Postgraduate School, Monterey, CA 93940.

Applications will be considered until March 15, 1983.

An Equal Opportunity/Affirmative Action Employer.

Two Lecturer Positions in Public Health and Water Engineering/The New South Wales Institute of Technology, Australia. The School of Civil Engineering at the New South Wales Institute of Technology, Sydney, Australia, seeks two lecturers to teach and administer subjects in its undergraduate and postgraduate courses. Applicants should possess postgraduate qualifications in civil or environmental engineering, preferably at Ph.D. level. For the public health position, experience in water and wastewater treatment and preparation of environmental impact statements would be desirable. For the water engineering position, applicants should have basic experience in hydrology or hydraulics, and experience in urban hydrology, computing, engineering economics or coastal engineering would be advantageous. Salary ranges for these positions will be $A22,430–$A29,467. The school has modern facilities including hydraulics and public health laboratories and a large computer system. Opportunities exist for research and outside professional involvement. Further information may be obtained from Dr. K. A. Faulkes, Head, School of Civil Engineering, at the address below. Written applications should include: address and phone number, personal particulars, evidence of qualifications, publications, research and professional work undertaken, and the names and addresses of three referees. Applications quoting reference number 83/023 (Public Health Position) or 83/028 (Water Engineering Position) should be sent to: The Appointments Officer, The New South Wales Institute of Technology, P.O. Box 123, Broadway, N.S.W., 2007, Australia, by 9th April, 1983.

Upper Ocean Physical Modeller. A postdoctoral position in upper ocean equatorial modelling supported by NSF is available in the Mesoscale Air-Sea Interaction Group at the Florida State University. Minimum salary is $21,000/yr. Qualified Ph.D. should send vita and names of 3 references to Professor James J. O'Brien, The Florida State University, Tallahassee, FL 32306, or call (904) 644-4581.

Economic Geology Geophysics. George Mason University seeks an economic geologist, geophysicist or structural geologist with geophysical training. The position is at the Assistant Professor level, tenure track, and will begin on September 1983. A Ph.D. is required, and the salary is competitive. GMU's Department of Geology is newly established, and the geology facilities are generous, with modern lab space, ample teaching supplies, equipment for teaching and research, and in-house research support. GMU is located within 20 km of the Carnegie Institution, Smithsonian Institution and many federal agencies of Washington, D.C. such as the USA National Center. Geologically, GMU is located in the Piedmont Province of the Appalachians, in close proximity to the Coastal Plain, Triassic Basin, Blue Ridge, Valley and Ridge and Appalachian Plateau Provinces. If interested, send your vita, a statement of your research interest and teaching interests, and the names of five people who know your professional abilities to: Douglas Mose, Chairman, Department of Geology, George Mason University, Fairfax, Virginia 22030. AA/EO

University of Mississippi/Department of Civil Engineering. The Department of Civil Engineering invites applications for an Assistant Professor level position Ph.D. in civil engineering or closely related field. Strong background in applied mathematics including stochastic processes and boundary value problems, will be given preference. Areas of research should include but not be limited to one of the following: space-time rainfall modeling, interaction problem of hill slope hydrology, hydrologic analysis at the basin scale with emphasis on channel network geomorphology, development of physically based erosion and sediment transport theories, subsurface transport processes in a spatially heterogeneous domain. Send resume and names of 3 references to Department of Civil Engineering, University of Mississippi, University, MS 38677.

Equal Opportunity Employer.

Unusual opportunity for Ph.D. Hydrologist. Tarleton State University, part of the Texas A&M University System, has been authorized to offer a B.S. Degree in Geology beginning with the Fall 1983 Semester. This will be the only such degree in the state of Texas and one of very few in the nation. The program will be administered by a Director in conjunction with an advisory board of outstanding professionals. The Director we are seeking must be an enthusiastic individual with extensive experience in and knowledge of the field of hydrology to develop this program to regional or national prominence. This will be a tenure-track appointment, rank and salary negotiable, and no duties administrative release time. Substantial funding has been awarded for facilities construction.

Applicants should send a resume and the names of three references to: Dr. Thomas C. Hinkson, Head, Department of Physical Sciences, P.O. Box T-69, Tarleton State University, Stephenville, Texas 76402, Telephone 817/968-9413.

The deadline for application is April 15, 1983. Tarleton State University, enrollment 4,300, offers Bachelors and Masters degrees, is located in Stephenville, Texas, a progressive city of 15,000 people, 65 miles southwest of the Dallas-Ft. Worth Metroplex, and is an affirmative action, equal opportunity employer.

Chairman—Department of Geological Sciences, Wright State University. The Department of Geological Sciences, invites applications for the position of chairman, to be appointed September 1984. We seek a dynamic individual with outstanding administrative talent and an appreciation for research and practice-related educational activities. Rank is at the full professor level and no restrictions have been placed on areas of specialization. The department is active with 12 faculty and an emphasis on professional practice, yet maintaining a firm commitment to basic research.

Send a letter of application, curriculum vitae and names of three references to:

Chairman, Search Committee
Department of Geological Sciences
Wright State University
Dayton, OH 45435.

Wright State University is an affirmative action/equal opportunity employer. Closing date for the position is October 31, 1983.

Postdoctoral in Field of Planetary Atmospheres. Start summer '83, for 18-month appointment, probably renewable, $17,500. Preferred research interests: climate modeling, net-energy, radiative transfer. Send vitae to Prof. J. W. Chamberlain, Space Physics and Astronomy, Rice University, Box 1892, Houston, TX 75251.

Postdoctoral Position in Space Plasma Physics. Dartmouth College invites applications for a one-year postdoctoral fellowship which will become available in June 1983. The recipient is expected to develop theoretical models of magnetospheric current sheets and boundary layers and to study various processes such as instabilities and magnetic field reconnection which occur in such layers.

Send letter of application, resume, and the names of two references by April 15 to Professor B. Sonnerup, Thayer School of Engineering, Dartmouth College, Hanover, New Hampshire 03755 (603/646-2883).

Dartmouth College is an equal opportunity/affirmative action employer.

University of Nebraska-Lincoln/Geology. Seek tenure-track Assistant Professor in general area of tectonics, geophysics, structure and economic geology effective August. Teaching duties can be arranged to reflect specialty of successful applicant. Teach two courses per semester. Requires Ph.D. and strong commitment to excellence in teaching and research/publication. Minimum salary $20,000. Apply by March 31 with application letter, vita, transcripts, and names of three references to Chairman, Department of Geology, University of Nebraska-Lincoln, Lincoln, Nebraska 68588–0340. Affirmative Action/Equal Opportunity Employer.

Postdoctoral Research Associate Positions/Johns Hopkins University, Applied Physics Laboratory. Positions are available for studies of planetary magnetospheres, and for studies of earth magnetospheric and auroral physics. Selected candidates will participate in the analysis and interpretation of data obtained from deep space probes (Voyager), or particle, field, and atmospheric emissions data from earth orbiting spacecraft. Positions are one year renewable opportunities with flexible starting dates. Applications should be addressed to Mr. Stevan F. Sayre, Department LER-258, The Johns Hopkins University, Applied Physics Laboratory, Johns Hopkins Road, Laurel, MD 20707.

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THE DEPARTMENT OF EARTH SCIENCES MEMORIAL UNIVERSITY OF NEWFOUNDLAND

is expanding into areas related to East Coast offshore geology, petroleum exploration and development and has two new and two replacement faculty positions:

These four tenure-track positions at the assistant/associate professor level will be available from July 1983 and applications are invited from specialists in:

- CLAY MINERALOGY
- MESOZOIC-CENOZOIC PALYNOLOGY
- STABLE ISOTOPE GEOCHEMISTRY
- ECONOMIC GEOLOGY (MINERAL DEPOSITS)
- CRUSTAL SEISMOLOGY

A Ph.D. in earth sciences or related field is required together with proven research and teaching capability; salary will be commensurate with qualifications and experience and will commence in the range $26,600–$41,500.

There is also a vacant one-year position as a Post-doctoral Fellow or Visiting Professor for teaching and research in TECTONICS. A vacant two-year position as Visiting Professor/PDF for teaching and research in CARBONATE SEDIMENTOLOGY will be available in 1984. Rank is open for both these positions.

Enquiries, or applications, with a curriculum vitae and the names of three referees should be sent to:

Dr. C. R. Barnes, Head
Department of Earth Sciences
Memorial University of Newfoundland
St. John's, Newfoundland, Canada
A1B 3X5
Telephone: (709) 737-8142

NOTE: *Preference will be given to candidates who are presently eligible for employment in Canada (Canadian citizens and landed immigrants). The above positions are subject to the availability of funds.*

STUDENT OPPORTUNITIES

Graduate Research Assistantships in Earthquake and Exploration Seismology, University of Kansas. The computer acquisition of digital seismograms for a 20 + station seismic network covering the southern end of the Central North American Rift System and the development of techniques for Very High Frequency (500-1000 Hz) reflection seismology provide excellent opportunities for graduate study at the M.S. or Ph.D. level. For further information and/or application, please write or call:

Dr. George H. Rothe, Chairman, Geophysics Program
Department of Geology, University of Kansas
Lawrence, Kansas 66045, (913) 864-4974.

Meetings

Announcements

Water Rights

The deadline for submission of abstracts for the one-day Symposium on Integration of Water Rights at the Specialty Conference of the Irrigation and Drainage Division of the American Society of Civil Engineers is March 15, 1983. The conference, to be held July 24–26, 1984, in Flagstaff, Ariz., aims to bring together scientists and practitioners of irrigation and drainage. The symposium will explore the application of water rights concepts to both surface and groundwater.

Potential contributors to the symposium should send abstracts of 200–300 words to Kenneth G. Renard, Southwest Watershed Research Center, 2000 E. Allen Road, Tucson, AZ 85719 (telephone: 602-629-6381). Acceptance notices will be sent by July 1983. Formal papers should be submitted by December 1983 for preprinting in the Proceedings of the Specialty Conference.

The Ground Water Committee and the Surface Water Committee of the Irrigation and Drainage Division are joint sponsors of the all day session.

Flood Warning, Water Management

Using data processing systems to solve water resources management and early flood warning problems is the focus of the United Nations and National Weather Service Flood Warning and Water Management Conference to be held in Sacramento, Calif., September 19–23, 1983.

Participants from more than 20 nations will explore low-cost, reliable microcomputer-based systems that are used to solve flood and drought problems. Sessions will review the field operation of computerized flood warning systems now in use in the United States, Pakistan, Argentina, Brazil, and Honduras. Additional discussions will examine the application of computer systems to short-term weather forecasting, local government administration, agricultural operations, energy production, water resources management, civil engineering and construction, and dam safety.

Registration is still open. Contact Robert J. C. Burnash, Hydrologist-in-Charge, California-Nevada River Forecast Center, 1416 9th Street, Sacramento, CA 95814 (telephone: 916-442-1201).

The World Meteorological Organization of the United Nations, the National Weather Service of NOAA, and the California State Department of Water Resources are jointly sponsoring the conference in cooperation with the U.S. Geological Survey, the U.S. Army Corps of Engineers; the U.S. Bureau of Reclamation, the American Meteorological Society, and the American Society of Civil Engineers.

Applied Climatology

The Third Applied Climatology Conference, sponsored jointly by the Committee on Probability and Statistics and by the Applied Climate Committee of the American Meteorological Society (AMS), will be held in Hot Springs, Ark., November 16–18, 1983. The meeting seeks to improve communication between the providers and the users of climate information.

Contributors wishing to focus on the problems of applied climate should submit abstracts of 100 words or fewer; these will be published in a preconference AMS *Bulletin*. Others wishing to address probability and statistics or a joint session of the two communities on a topic of mutual interest should forward a camera-ready abstract of 200–400 words plus diagrams; such abstracts will be published in a preprint volume. All abstracts should be sent to Wayne M. Wendland, Illinois State Water Survey, P.O. Box 5050, Station A, Champaign, IL 61820. Submission deadline is April 15, 1983.

Specific details of the conference may be found in recent issues of the AMS *Bulletin*.

Breccias

Geological occurrence and genesis is the focus of the Brecciation and Mineralization invitational research conference to be held in Colorado Springs, Colo., September 18–22, 1983.

Topics to be covered include types of breccias; the causes of brecciation; related alteration and mineralization; zoning; stable isotope and fluid inclusion studies; genetic association with ore depositing mechanisms; and the assessment of recent advances and unresolved issues.

For additional information, contact Leanne Stone, Division of Continuing Education, University of Nevada-Reno, Reno, NV 89557 (telephone: 702-784-4046).

IUGG: ICL Update

The Inter-Union Commission on the Lithosphere (ICL) recently announced the schedule for symposia it will sponsor during the International Union of Geodesy and Geophysics (IUGG) General Assembly in August (*Eos*, January 25, 1983; pp. 29–35).

'Structure, Composition, and Dynamics of the Continental Lithosphere' is slated to be held August 16 and August 18. 'Passive Continental Margins' will be held August 23–24. 'Appalachian and Hercynian Fold Belts' will be held on August 25–26. 'Desert Encroach-

ment, Fast Tropical Erosion, and Coastal Subsidence and Submergence' will be held August 22–23. Most of the symposia will be held during half-day sessions.

For additional information, contact Edward A. Flinn, ICL Secretary-General, Geodynamics Program, NASA Headquarters, Code EL-4, Washington, DC 20546 (telephone: 202-755-3848).

Geophysical Year

New Listings

The complete Geophysical Year last appeared in the December 21, 1982, *Eos*.

A boldface meeting title indicates sponsorship or cosponsorship by AGU.

September 18–22, 1983 Brecciation and Mineralization Invitational Conference, Colorado Springs, Colo. (Leanne Stone, Division of Continuing Education, University of Nevada-Reno, Reno, NV 89557; telephone: 702-784-4046).

July 24–26, 1984 Water Rights Specialty Conference, Flagstaff, Ariz. One-day Symposium on Integration of Water Rights is part of conference. Sponsors of the symposium, Ground Water Committee and Surface Water Committee of the Irrigation and Drainage Division of the American Society of Civil Engineers. (Symposium contact, Kenneth G. Renard, Southwest Watershed Research Center, 2000 E. Allen Road, Tucson, AZ 85719; telephone: 602-629-6381.)

The Climatic Effects of Volcanic Dust and Aerosols in the Upper Atmosphere

Friday, March 18, 1983
8:30 a.m.–5:00 p.m.

National Bureau of Standards Auditorium
325 Broadway, Boulder, Colorado

Sponsored by the AGU Front Range Branch and cosponsored by the Denver/Boulder chapter of the American Meteorological Society, the symposium is partially supported by grants from Ball Brothers Aerospace Corp., the Cooperative Institute for Research and Environmental Science, NOAA, and USGS.

This symposium will bring together prominent researchers in the fields of climatology, meteorology, glaciology and volcanology to summarize the state of knowledge on this subject in an interdisciplinary forum at a level appropriate for a non-specialized, but scientifically literate audience. The meeting is open to the public.

Topics will include:
- The history and causes of climatic variations
- Explosive volcanism
- Atmospheric effects and observations
- Climatic and cultural consequences.

Contacts: Jules Friedman and Raymond Watts, U.S. Geological Survey, P.O. Box 25025 Mail Stop 964, Denver, CO 80225 (303) 234-3676 (Friedman) or 234-3493 (Watts).

For further information, see Eos Meetings Section, February 15, 1983.

AGU

Membership Applications Received

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary section affiliation; the letter A denotes the Atmospheric Sciences section, which was formerly the Meteorology section.

Regular Member

Gerard A. Eldin (O), David W. Fahey (A), Francois Faucher (G), Michael Ghil (A), Michael Griggs (A), John T. Gunn (O), Thomas A. Hauge (T), Yin-Nan Lee (A), Fernando De Miguel (S), Shirley A. Pomponi (O), Rob P. Rechard (H), Ping-Tung Shaw (O), Che Kwan Shum (G), Michael J. Smith (T), Francisco Vidal (S), Jesse L. Yow (T).

Student Member

Scott G. Borg (V), Sean Carson (S), Kenji Degutschi (H), Perry R. Malcolm (SM), Edward R. Millin (H), James C. Sample (T), Everett L. Shock (V), Henrique Tono (S), Alan M. Volpe (O), Patricia J. White (T).

Associate Member

Leonard N. Cormier, Kevin W. Martindale (S).

Membership Update

The following individuals have been added to the list of Supporting Members. The full list was last published in the November 30, 1982, *Eos* and updated in the January 25, 1983, issue.

Individual Supporting Members

Celso S. Barrientos, Joseph C. Cain, Albert P. Crary, J. Freeman Gilbert, Albert W. Kaddatz, William Markowitz, J. Murray Mitchell, Jr., Kendall L. Svendsen, and Gordon A. Young.

GAP

Separates

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Aeronomy

0460 Tides, waves and winds
THE DYNAMIC RESPONSE OF THE HIGH-LATITUDE THERMOSPHERE AND GEOSTROPHIC ADJUSTMENT
W. F. Larsen (School of Electrical Engineering, Cornell University, Ithaca, New York, 14850), I. S. Mikkelsen

We find that certain features of the response of the high-latitude thermosphere to inputs of energy and momentum can be explained qualitatively in terms of the theory of geostrophic adjustment. The theory is well known in the fields of oceanography and meteorology. The adjustment process is critically dependent on the ratio of the scale size of the forcing to the Rossby radius of deformation, a natural parameter of the open atmospheric state. When the ratio is small, large wind speeds are efficiently generated by a momentum source. When the ratio is large, changes in the mass field associated with a heat source are more effectively produced. The variation of the Rossby radius with height explains the qualitatively different responses of the high-latitude E and F regions during disturbed geomagnetic conditions as shown by both observations and numerical models. The E region is a more efficient generator of large winds, whereas the F region creates perturbations equally well in the mass field and the wind field. Earlier results by Dickinson et al. (1971) and Volland and Mayr (1971) are explained in terms of geostrophic adjustment, and the analytic solutions are compared to the results of the integration of the spectral numerical model of Mayr and Harris (1978). We find that the analytic solutions are in good agreement with the model results regarding the apportionment of energy between the divergent and rotational components of the wind field as a function of wavenumber.
J. Geophys. Res., Blue, Paper 3A0033

Electromagnetics

6785 Tropospheric Propagation (Line-of-Sight Systems)
MICROWAVE RADIO METEOROLOGY: SEASONAL FADING DISTRIBUTIONS
James A. Schiavone (Bell Laboratories, Murray Hill, New Jersey 07974)

Refractive fading can significantly impair service on terrestrial line-of-sight microwave transmission systems. Digital radio systems are vulnerable to this fading which is produced by vertical gradients in the microwave refractive index. A characterization of the seasonal variation in fading and its dependence upon meteorological parameters provides the potential to improve transmission performance by better tailoring of transmission equipment design and usage to the amount of fading expected at a given location and time of year.

In this work we study the seasonal variation in fading occurrence at Palmetto, Georgia over a 28-month period. The changes in the shapes of seasonal fading distributions as a function of fade threshold, path length, and antenna height are examined and interpreted meteorologically. The Palmetto distributions are compared with those measured at other worldwide locations and the year-to-year fading variability for Palmetto is estimated. The Palmetto studies show that mean monthly wind speed, V, is the best meteorological predictor of monthly accumulated time that signal is below -20 dB, t_{20} at Palmetto. The predictor is $t_{20} = 17600\,(12/V-1)^2$ and has a correlation coefficient of 0.88. Year-to-year variability in observed fading is greatest in early autumn when monthly accumulated 20 dB fading time differs by about 6000 seconds between years. Seasonal distribution shapes depend strongly on geographical location. The studies comparing different worldwide distributions show that 95% of the total annual fading occurs during the season experiencing monthly water vapor pressures >10 millibars and that the peak in the seasonal fading distributions, outside of low latitude coastal regions, is associated with the months in the humid season when there is the least precipitation. (Line-of-sight paths, transmission performance, anomalous propagation).
Rad. Sci., Paper 3S0254

Geochemistry

1410 Chemistry of the atmosphere
SOURCES, SINKS, AND SEASONAL CYCLES OF ATMOSPHERIC METHANE
M.A.K. Khalil (Department of Environmental Science, Oregon Graduate Center, Beaverton, Oregon 97006) and R.A. Rasmussen

It is shown that a long lifetime of about 8 years is most consistent with the observed latitudinal variation of atmospheric methane, requiring the current global emissions of methane to be around 550 teragrams per year (Tg = 10^{12} gm). On average there is 25-34 ppbv less methane in the atmosphere of the northern hemisphere during summer compared to the rest of the year. Methane concentrations rise rapidly to their yearly peaks in fall. Seasonal cycles of CH_4 concentration in the southern hemisphere include lowest concentrations during the late Australian summer and fall, being about 14 ppbv less than during the rest of the year. The repeating pattern of a rapid rise of CH_4 concentrations during fall in the northern hemisphere suggests a large fall source at latitudes above 30°N. The remaining observed seasonal variations are consistent with the seasonal cycle of OH, which removes methane from the atmosphere. The extensive set of self-consistent measurements of methane is reported and analyzed, showing that methane has increased during the past 3-4 years at rates of 1 to 1.9% per year, all over the world at sites ranging from inside the arctic circle to the south pole. Observational results are used to estimate the sources, sinks, and seasonal cycles of CH_4, and the effects of human activities on its atmospheric abundance. (Trends, seasonal cycles, lifetimes, global distribution)
J. Geophys. Res., Green, Paper 3C0214

1410 Chemistry of the atmosphere
BALLOON BORNE LIDAR MEASUREMENTS OF STRATOSPHERIC HYDROXYL RADICAL
Wo. S. Heaps (NASA/Goddard Space Flight Center, Laboratory for Planetary Atmospheres, Code 963, Greenbelt, MD 20771) T. J. McGee

A balloon borne laser radar (LIDAR) system for the determination of stratospheric hydroxyl radical concentration has been constructed and flown by Goddard Space Flight Center. The system measured hydroxyl in the 34-37 kilometer altitude range throughout an afternoon and early evening yielding the first post-sunset hydroxyl determinations ever obtained. Daytime values ($\sim 5\times10^6$ cm^{-3}) were somewhat lower than previous measurements using in situ resonance fluorescence. Nighttime values ($\sim 7\times10^5$ cm^{-3} 02100 CDT) were higher than predicted by current 1-D models. Possible sources of these discrepancies along with improvements possible in future systems are outlined. (Stratosphere, ozone, hydroxyl radical)
J. Geophys. Res., Green, Paper 3C0037

1599 General (Carbon Cycle)
$^{13}C/^{12}C$ RECORDS IN NORTHERN HEMISPHERIC TREES DURING THE PAST 500 YEARS, ANTHROPOGENIC IMPACT AND CLIMATIC SUPERPOSITIONS
H.D. Freyer (Institute of Atmospheric Chemistry, Nuclear Research Center, KFA, D-5170 Jülich, Federal Republic of Germany) and N. Belacy

$^{13}C/^{12}C$ data are reported for the past 500 years on two sets of European oak forest trees from the German Spessart and free-standing Scots pine trees from Muddus National Park, Sweden. While the forest trees show large non-systematic variations in the $^{13}C/^{12}C$ ratio over the 500 years, the $^{13}C/^{12}C$ record for the free-standing trees shows smaller fluctuations, which can be correlated to climatic changes. Since industrialization in 1850 AD, the $^{13}C/^{12}C$ record for the free-standing trees is dominated by a systematic decrease of about 2 ‰, which is comparable with other mean $^{13}C/^{12}C$ tree rings data. The calculated Northern Hemisphere $^{13}C/^{12}C$ record derived from a total of about 50 trees reflects the recent $^{13}C/^{12}C$ change in atmospheric CO_2 observed from 1956 to 1980 AD. ($^{13}C/^{12}C$ in tree rings, anthropogenic CO_2 impact, paleoclimatology).
J. Geophys. Res., Green, Paper 3C0276

1499 Miscellaneous (Sea-salt production)
PRODUCTION RATE OF AIRBORNE SEA-SALT SULFUR DEDUCED FROM CHEMICAL ANALYSIS OF MARINE AEROSOLS AND PRECIPITATION
G. Várhelyi (Institute for Atmospheric Physics, H-1675 Budapest, P.O.Box 39, Hungary) and G. Gravenhorst

On the basis of a thorough compilation of the results of measurements of marine aerosols and precipitation the total sulfur deposition into the oceans is estimated to 180-350 Tg S yr^{-1}. From this amount 120-250 Tg S yr^{-1} is attributed to sea-salt sulfur deposition while 60-100 Tg S yr^{-1} to "excess sulfur". By assuming a sea-salt transport ratio of 10 % into continental air it is concluded that the annual production rate of sea-salt sulfur is about 130-275 Tg S yr^{-1}, several times higher than previously estimated.
J. Geophys. Res., Green, Paper 2C1989

Hydrology

3130 Groundwater
ANALYTIC SOLUTIONS FOR RECTANGULAR AQUIFERS WITH THIRD KIND (CAUCHY) BOUNDARY CONDITIONS
M. Yavuz Corapcioglu (Department of Civil Engineering, University of Delaware, Newark, Delaware, 19711), Osman Borekci and Ajit Haridas

Closed form analytical solutions for the drawdown due to a single well pumping at a constant rate from a rectangular aquifer with third kind (Cauchy) boundary conditions are obtained by employing the finite Fourier integral transforms. Three illustrative examples are considered and the solutions are generated at the spatial and temporal locations of interest.
Water Resour. Res., Paper 3W0102

3130 Groundwater (Mathematical models)
AN EIGENVALUE NUMERICAL TECHNIQUE FOR SOLVING UNSTEADY LINEAR GROUNDWATER MODELS CONTINUOUSLY IN TIME.
A. Sahuquillo (Servicio Geológico de Obras Públicas, Avenida de Portugal, 81, Madrid-11, SPAIN).

A procedure for solving the differential groundwater flow equation is presented herein. Using a finite difference or finite element discretization scheme, a set of simultaneous linear equations is obtained. The eigenvalues and eigenvectors of a matrix which is a function of the coefficients of the set, are the key to the solution. A vector L is obtained straight forward by combining the eigenvector matrix A, the eigenvalue vector α, the pumping vector P and the initial head vector H. Vector L which depends on time, can be expressed simply and explicity as a function of the eigenvalues. Piezometric heads can be obtained combining A and L. L is the only vector that needs to be computed as P changes with time.

In this way, influence functions of a piezometric head, flow velocity and flow depletion of a stream connected with the aquifer under a unit stress, can be obtained explicitly and continuously in time.

The method can be applied to confined as well as to leaky aquifers, 1, 2 or 3 dimensional linear models. Its main advantage lies in the fact that it is unnecessary to repeatedly solve a matrix for ...

management problems in which a large number of alternatives have to be evaluated. (Management, conjunctive use).
Water Resour. Res., Paper 2W1657

Meteorology

3720 Climatology
ORBITAL FORCING, CLIMATIC INTERACTIONS AND GLACIATION CYCLES
B. LeTreut and M. Ghil (Courant Institute of Mathematical Sciences, N.Y.U., 251 Mercer St., New York, N.Y. 10012)

We consider forced oscillations of a nonlinear climatic oscillator. The oscillator includes radiation balance, oceanic thermal inertia, a highly simplified hydrological cycle, the mass balance and plastic flow of ice sheets, the elasticity of the Earth's crust and the viscosity of its upper mantle, as well as their various interactions. This system exhibits self-sustained periodic oscillations with a free period of roughly 10,000 yr (10 ka).

The model is subjected to forcing at the astronomical periodicities of precession, 19 ka and 23 ka, obliquity, 41ka, and eccentricity, 100ka and 400ka. The forcing is assumed to act on the climatic system by variations in mean annual insolation. In the case of eccentricity, as well as by its effect on the ice-mass balance through the nonlinear precipitation-temperature feedback. Nonlinearly resonant response to the forcings leads to large changes in global temperature T and ice mass V; this response obtains at the frequency of the forcing, due to the mechanism of entrainment. The nonlinear character of the response also leads to combination tones. These are linear combinations of the forcing frequencies with integer coefficients, among which the largest occur near 100ka and 10 ka.

Sharp peaks in spectral density at the forcing frequencies and at their combination tones are superimposed on a continuous background. The spectral power in the background decreases with increasing frequency, like random red noise. This deterministic aperiodic behavior limits the predictability of glaciation cycles.

(Quaternary glaciation cycles, nonlinear oscillations, climatic variability, predictability of climate).
J. Geophys. Res., Green, Paper 3C0176

3735 Electrical Phenomena
PLANETARY LIGHTNING
Mark A. Williams (Institute of Atmospheric Physics, University of Arizona, Tucson, AZ 85721), E. Philip Krider and Donald M. Hunten

Terrestrial lightning is usually produced by convective clouds that contain supercooled water, ice, and precipitation. Although convection and a variety of mechanisms based on the principle of electrostatic induction can, in principle, electrify clouds, the available evidence suggests that interactions between riming ice particles and supercooled water, followed by a gravitational separation of charged precipitation elements, is the dominant mechanism for cloud electrification on Earth. These mechanisms probably operate on Jupiter in the H_2O cloud, and optical images of lightning and whistlers have been detected by Voyager 1. Jupiter has no true surface; therefore, the Jovian lightning flashes are cloud discharges. Observations indicate that Jovian lightning emits, on average, 10^{10} J of optical energy per flash, whereas lightning on earth radiates only about 10^6 J per flash. There is much uncertainty in the average planetary lightning rate on Jupiter, but estimates range from 3.10^{-3} to 40 km^{-2} yr^{-1}, whereas the global rate for lightning on Earth is probably 1 to 3 km^{-2} yr^{-1}. Venera probes have reported transient LF and VLF radio emissions in the lower atmosphere of Venus, and an experiment aboard the Pioneer Venus Orbiter has registered electromagnetic energy propagating in the whistler mode. Optical searches for lightning on Venus have been inconclusive, but have set an upper limit to the planetary flashing rate of about 30 km^{-2} yr^{-1}. The Venus observations have led to widespread speculation that there is lightning in the atmosphere, but application of known charging mechanisms to the Venus environment does not suggest that there should be strong electrification. Since the spacecraft observations do not conclusively show that lightning does occur on Venus, we suggest that alternative explanations for the experimental results be explored.
Rev. Geophys. Space Phys., Paper 3R0311

3770 Particles and aerosol
THE TRANSPORT OF MINERAL AEROSOL FROM ASIA OVER THE NORTH PACIFIC OCEAN
Mitsuo Uematsu (Center for Atmospheric Chemistry Studies, Graduate School of Oceanography, University of Rhode Island, Kingston, RI 02881), Robert A. Duce, Joseph M. Prospero, Liqi Chen, John T. Merrill and Ray L. McDonald

Concentrations of atmospheric aluminum - a good indicator of mineral aerosol - have been measured weekly between January, 1981 and March, 1982 at the seven stations (Shemya, Midway, Oahu, Enewetak, Fanning, Guam and Belau) of the SEAREX Asian Dust network in the North Pacific. A seasonal transport pattern was found at most of the sites, with high Al concentrations occurring during February-June and low concentrations during July-January. There was a latitudinal gradient in the mean annual atmospheric dust concentration, with the greatest concentrations occurring in the mid-latitudes. When coupled with statistics of dust storms in Asia and of Kosa (dense dust hazes traced to Chinese origins) in Japan, the data suggest that the dust collected in the network was transported by the westerlies from arid regions in Asia. It is estimated that 6-12 x 10^6 tons of Asian dust are transported annually to the central North Pacific; larger quantities are probably deposited over the western North Pacific closer to the Asian sources. This atmospherically transported mineral aerosol is a significant source of sedimentary material for the North Pacific. (Atmospheric Al concentration, dust input to the ocean, long range transport, mineral aerosol)
J. Geophys. Res., Green, Paper 3C0264

3799 General Meteorology
ANALYSIS OF UPPER STRATOSPHERIC OZONE PROFILE DATA FROM THE GROUND-BASED UMKEHR METHOD AND THE NIMBUS-4 BUV SATELLITE EXPERIMENT
Gregory C. Reinsel (Statistics Department, University of Wisconsin, Madison, Wisconsin, 53706), G.C. Tiao, R.A. Lewis, and M. Bobkoski.

We present a statistical trend analysis of stratospheric ozone profile data in the five highest Umkehr layers (layers 5-9), which cover approximately the 24 to 48 km region of the stratosphere, from the ground-based Umkehr measurements and from the Nimbus-4 BUV satellite experiment. Time series modeling of monthly Umkehr profile ozone data in Umkehr layers 5-9 from a collection of 13 ground-based Dobson stations over the period 1958-1980 is considered for the detection of trends which may be associated with the release of CFMs. Using a random effects model to account for various sources of variation among individual station trend estimates in each Umkehr layer, our findings show little evidence of any significant trend in ozone in any of the Umkehr layers over the period 1970-1980. Those trend results depend to some extent, of course, on the particular choice of explanatory factors employed in the time series models to describe variations in the Umkehr data. A possibly important source of variation on the Umkehr data, especially in the uppermost two or three layers, which has not been explicitly accounted for in these models is the presence of stratospheric aerosols, due primarily to volcanic activity. The possible impact of such aerosol effects on long term trend estimates obtained from Umkehr data is currently under investigation and results of such an analysis will be presented in a future report.

We also analyze BUV ozone profile data from the Nimbus-4 satellite over the period April, 1970 to April, 1977. These BUV profile data have first been interpolated to yield ozone amounts corresponding to the Umkehr layers 5-9. The globe has then been gridded into blocks of 10° latitude by 20° longitude, and monthly averages of ozone have been computed for the layers 5-9 for each block. Linear regression models which contain a linear trend term are estimated from the monthly BUV time series data for each of the five Umkehr layers in each block over the seven year period April, 1970 to April, 1977. The results show a large negative overall trend on the order of 1.5 to 2.0% per year in the BUV data at Umkehr layers 8 and 9, with little or no trend indicated in layers 5 and 6. However, a comparison of monthly BUV satellite data with the corresponding Umkehr ground profile ozone data is also performed, which indicates a substantial downward drift in the BUV data at layers 8 and 9, relative to the collection of Umkehr stations, of about the same magnitude as the estimated trend in BUV data in those layers. (Profile ozone, Umkehr, BUV, trend analysis).
J. Geophys. Res., Green, Paper 3C0280

Mineralogy, Petrology, and Crystal Chemistry

4210 Crystal Chemistry
CRYSTAL STRUCTURE AND MÖSSBAUER SPECTRUM OF VONSENITE, 2FeO·FeBO$_3$
J.S. Swinnea and H. Steinfink (Materials Science Laboratories, Department of Chemical Engineering, The University of Texas, Austin, Texas 78712)

The crystal structure of the mineral vonsenite has been redetermined from a synthesized specimen of composition 2FeO·FeBO$_3$. The unit cell dimensions are a=9.463(1) Å, b=12.305(1) Å, c=3.0727(6) Å, Z=4, space group Pbam. The final coordinates gave R=0.054 and $_wR$=0.029 for 614 structure amplitudes and R=0.030 and $_wR$=0.027 for 461 amplitudes greater than 3σ(F). The crystal structure is essentially unchanged from the structure reported in 1950 but the precision of the parameters is at least an order of magnitude better. Values of valence sums, Mössbauer spectra, and the distortions present in the four crystallographically independent octahedra containing Fe1, Fe2, Fe3 and Fe4 are consistent with the presence of two pairs of physically distinct iron ions. Fe1 and Fe3 are divalent; the bond distance between Fe2 and Fe4 is 2.787 Å and direct exchange occurs so that an intermediate oxidation state of +2.5 is observed. The Mössbauer spectra are complex and indicate the presence in the structure of Fe^{2+}, Fe^{3+} and $Fe^{2.5+}$. As the temperature is lowered from room temperature the Mössbauer spectra show the migration of a low velocity peak due to Fe^{3+} towards the high velocity peak due to the dinuclear complex Fe2-Fe4 in which Fe has an intermediate valence state. At room temperature charge delocalization is present over the three dimensional structure because the nearest Fe2-Fe2 and Fe4-Fe4 distances of 3.073 Å parallel to c provide a path. However, as the temperature is lowered this rather large Fe-Fe distance becomes a barrier to delocalization and only the charge transfer between Fe2-Fe4 remains. (Crystal structure, Mössbauer spectroscopy)
Am. Min., 68, 7-8

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CRITICS AND BIBLIOGRAPHY

CHRONICLE

4210 Crystal Chemistry
THERMAL STABILITY OF THE STILBITE-TYPE FRAMEWORK: CRYSTAL STRUCTURE OF THE DEHYDRATED SODIUM/AMMONIUM EXCHANGED FORM
W. J. Mortier (Centrum voor Oppervlaktescheikunde en Colloïdale Scheikunde, Katholieke Universiteit Leuven, De Croylaan 42, B-3030 Leuven (Heverlee), Belgium)

The crystal structure of dehydrated, 70% NH_4/30% Na exchanged stilbite has been refined space group C2/m [a = 13.57 Å, b = 18.26 Å, c = 11.32 Å, β = 126.96°]. The framework characteristics are consistent with those of the dehydrated B-form but with 10% of the T-O-T bridges between the secondary building units destroyed. The Al, extracted from the framework forms an "incompletely inverted" tetrahedron inside the secondary building unit (zeolite, stilbite, stability, topotactic transformation).
Am. Min., 68, 3-4

4230 Experimental mineralogy and petrology
CALORIMETRIC INVESTIGATION OF THE EXCESS ENTROPY OF MIXING IN ANALBITE-SANIDINE SOLID SOLUTIONS: LACK OF EVIDENCE FOR Na, K SHORT-RANGE ORDER AND IMPLICATIONS FOR TWO-FELDSPAR THERMOMETRY
H. T. Haselton, Jr. (USGS, 959 National Center, Reston, VA, 22092) G. L. Hovis (Dept. of Geology, Lafayette College, Easton, PA, 18042) B. S. Hemingway (USGS, 959 National Center, Reston, VA, 22092) R. A. Robie (USGS, 959 National Center, Reston, VA, 22092).

Heat capacities (5-380 K) have been measured by adiabatic calorimetry for five highly disordered alkali feldspars ($Ab_{99}Or_1$, $Ab_{85}Or_{15}$, $Ab_{55}Or_{45}$, $Ab_{25}Or_{75}$, and Ab_1Or_{99}). Positive heat capacity deviations from a linear combination of the end-member heat capacities, which are present mostly at very low temperatures, result in an excess entropy at 298.15 K for intermediate compositions. The excess entropy is well described by the symmetric expression $S^{ex}_{298} = X_{Ab}X_{Or}(10.3 \pm 0.1$ J/mol·K). For practical calculations, the entropy and enthalpy of mixing can be regarded as temperature-independent above room temperature.

The excess entropy and volume of mixing have been combined with solvus determinations to obtain a calculated enthalpy of mixing. Because the measured enthalpies of mixing are essentially coincident with those calculated from the solvus determinations, no short-range order for the alkali site could be inferred.

The new data for the alkali feldspars have been combined with recent data for plagioclase feldspars to derive an expression for the two-feldspar thermometer that is consistent with present knowledge of the thermodynamics of these solid solutions. Temperatures calculated from this expression tend to be higher than those calculated from previous formulations.
Am. Min., 68, 3-4

4260 Paragenesis, petrography, and petrogenesis
ILVAITE, AN ALTERATION PRODUCT REPLACING OLIVINE IN THE SKAERGAARD INTRUSION
B. R. Naslund (Department of Earth Sciences, Dartmouth College, Hanover, New Hampshire, 03755), J. H. Hughes, and D. M. Birnie

Ilvaite, $CaFe_2^{2+}Fe^{3+}(OH)Si_2O_8$ is an abundant mineral in the upper part of the Skaergaard intrusion of East Greenland. It occurs in these rocks as an alteration product replacing fayalitic olivine. Analyses of unaltered olivine and ilvaite demonstrate that the replacement process requires the removal of FeO and MgO from the olivine and the addition of CaO, H_2O, and O_2. Single crystal X-ray diffraction studies indicate that the Skaergaard ilvaite is the orthorhombic polymorph. It is suggested that the ilvaite crystallized under conditions of high fH_2O, low fCO_2, low fO_2, and moderate T during the subsolidus cooling of the intrusion.
Am. Min., 68, 5-6

4260 Paragenesis, petrography, and petrogenesis
REVERSALS IN FE-MG PARTITIONING BETWEEN CHLORITOID AND STAUROLITE
Jeffrey A. Grambling (Department of Geology, University of New Mexico, Albuquerque, New Mexico 87131)

Chloritoid and staurolite coexist with Al silicate, chlorite, or garnet ± biotite in Precambrian quartzite and schist from northern New Mexico. Textural and chemical considerations indicate that the minerals crystallized in equilibrium. Chloritoid and staurolite show a reversal in Fe-Mg partitioning: chloritoid consistently is more Fe-rich than staurolite in samples with $X_{Fe,ctd}$ = 0.95 to 1.00, but chloritoid is more magnesian than staurolite in samples with $X_{Fe,ctd}$ less than 0.90. Fe-Mg distribution coefficients vary with mineral composition. Linear regression suggests that chloritoid and staurolite should have equal X_{Fe} near 0.909, but only one sample has a composition in that range, and it contains staurolite (X_{Fe} = 0.93) coexisting with chloritoid of variable composition (X_{Fe} = 0.90 to 0.95). The observed Fe-Mg reversal is not related to variable P, T, or minor element content, including Fe^{3+}. However, it could arise from any of three factors: (1) Fe and Mg may occur on several crystallographic sites in one or both minerals; (2) some Mg may not be exchangeable with Fe in staurolite; or (3) Fe and Mg may mix non-ideally in one or both phases. (Metamorphic petrology, chloritoid, staurolite)
Am. Min., 68, 3-4

4260 Paragenesis, petrography, and petrogenesis
PETROGENESIS OF THE CONCORD GABBRO-SYENITE COMPLEX, NORTH CAROLINA
B. A. Olsen (Dept. of Geological Sciences, University of Tennessee, Knoxville, Tennessee, 37996), H. Y. McSween, Jr. and T. W. Sando

The Concord intrusive complex, Cabarrus County, North Carolina, consists of a large gabbro stock enveloped by a horseshoe-shaped syenite ring dike. The complex is clearly delineated from surrounding rocks by magnetic and radioactivity anomalies. Gravity modeling suggests that the gabbro pluton extends to a depth of about 6 km and that the syenite ring dike dips steeply outward at an angle of 78° on the west side and dips vertically on the east side. A Sm-Nd mineral isochron for gabbro and a Rb-Sr isochron for syenite indicate that the two lithologies were emplaced contemporaneously ..405 m.y. ago. Initial Nd and Sr isotopic compositions of gabbro and syenite in this complex overlap, suggesting the two rock types may be related through closed-system fractional crystallization.

Three gabbroic rock types are distinguished, based on the presence of different cumulus minerals: olivine-clinopyroxene, olivine-clinopyroxene-plagioclase, and clinopyroxene-plagioclase. All gabbros contain postcumulus orthopyroxene and hornblende (± clinopyroxene), as well as minor biotite, Fe-Ti oxides, sulfides, and apatite. The syenite is a seriate porphyry with megacrysts of perthitic feldspar in a groundmass of albite, microcline, clinopyroxene, amphibole, biotite, quartz, Fe-Ti oxides, pyrite, apatite, zircon and monazite. Geochemical modeling of major and trace element variations indicates that the Concord syenite could be produced by fractionation of olivine, plagioclase, clinopyroxene, and minor Fe-Ti oxide minerals, of the same compositions as observed cumulus phases in the Concord gabbro, from a basaltic parental magma similar in composition to the Concord gabbro. This gabbro-syenite trend probably represents differentiation of a tholeiitic basaltic melt near a thermal divide along the critical plane of silica undersaturation. This fractionation took place in a magma reservoir at depth, before intrusion of the syenitic residual liquid into the fractured region between previously intruded gabbro and country rocks.
Am. Min., 68, 3-4

4260 Paragenesis, petrography, and petrogenesis
MINERAL REACTIONS AND ELEMENT MIGRATION DURING METAMORPHISM OF CALCAREOUS SEDIMENTS FROM THE VASSALBORO FORMATION, SOUTH-CENTRAL MAINE
J. M. Ferry (Department of Geology, Arizona State University, Tempe, Arizona 85287)

Whole-rock chemical data for a suite of metamorphosed carbonate rocks from a single stratigraphic unit indicate that K, Na, and CO_2 were progressively lost from the rocks during the metamorphic event. Average rocks collected at the highest grades contain only 18% as much K and only 31% as much Na as do average rocks collected at the lowest grades. Extraction of Na and K occurred over a wide range of metamorphic grades, but extraction of Na began at lower grade conditions than did extraction of K. The chemical data and petrological arguments are consistent with no mass transfer of Fe, Mg, Ti, Si, or Ca relative to a constant aluminum reference frame. Consideration of the compositions and proportions of minerals in the metacarbonate rocks, and of whole-rock chemistry leads to the inferred mechanisms by which K and Na were lost. Sodium was probably lost through a mineral-fluid hydrolysis reaction that destroyed plagioclase and formed ... fluid species. Potassium was probably lost independently through a mineral-fluid hydrolysis reaction that destroyed biotite and formed calcic amphibole, sphene, anorthite, and a soluble K-bearing fluid species. The reactions indicate that H_2O was progressively lost during metamorphism as well as K, Na, and CO_2. The observed amount of mass transport of K and Na requires that 1-10 rock volumes of fluid interacted with the carbonate rocks during metamorphism. The large fluid volumes and the observed hydrolysis reactions lead to a model that considers regional metamorphism in the area as possible large-scale acid infiltration metasomatism. (Regional metamorphism, fluid-rock interaction, mass transfer).
Am. Min., 68, 3-4

Oceanography

4713 Circulation
SURVEY OF GULF STREAM FRONTAL FILAMENT
Leonard J. Pietrafesa (Department of Marine, Earth and Atmospheric Sciences, Raleigh, North Carolina)

An assortment of data is used to map and characterize a Gulf Stream filament. During 21-25 April, 1980, a filament was captured as it moved through an array of moored current meters on the northeast Florida continental shelf. Current and temperature time series along with satellite VHRR and aircraft ART are used to reconstruct the event. The event is found to consist of an anticyclonically rotating, warm tongue inshore of a cold dome. The rotational scheme of the current in the warm tongue is opposite to previous hypotheses. Upwelling occurs in both the cold dome region and below the warm tongue. (Gulf Stream, frontal events, filaments).
Geophys. Res. Lett., Paper 2L1825

4740 General
TEMPORAL VARIATIONS OF BEAM ATTENUATION COEFFICIENT ON THE CONTINENTAL RISE OFF NOVA SCOTIA
H. Pak and R.V. Zaneveld (School of Oceanography, Oregon State University, Corvallis, OR 97331)

Two separate time series observations of light transmission at λ = 660 nm. The range corresponds approximately to SPM concentrations of 12 mg/l to 150 μg/l. The former is the maximum value determined by filtration (Biscaye, 1980) and the latter is determined by an empirical relation between beam attenuation coefficient and particle volume determined by a particle counter. Nepheloid layers of significant turbidity, called benthic storms, were observed in 30% and 10% of the time, respectively, for the two observations, and each storm lasted 2 to 5 days. High frequency fluctuations represented by pulse lengths less than 10 minutes were observed superimposed on the low frequency fluctuations during 16 and 4% of the time. Both the major storms and high frequency pulses are interpreted to be a result of resuspension of bottom sediments at varying distances from the instrument, the high frequency pulses are thought to be a result of erosion at a relatively short distance while the low frequency fluctuations result from erosion at greater distance.
J. Geophys. Res., Green, Paper 3C0248

4765 Tides (Bay of Bengal)
TIDES IN THE BAY OF BENGAL
T.S. Murty and R.F. Henry (Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., V8L 4B2, Canada)

The amplitudes and phases of the tidal constituents M_2, S_2, K_1 and O_1 in the Bay of Bengal are deduced from tide gauge records at 112 locations, with the aid of numerical models based on the vertically integrated equations of motion and continuity. Tidal elevations along the southern open boundary of the bay were obtained by interpolation from observations. The results are presented in the form of co-tidal charts. These show that the constituents examined have no amphidromic points in the Bay of Bengal, apart from a degenerate amphidrome for M_2 in the northwest part of the bay. (Tides, Bay of Bengal).
J. Geophys. Res., Green, Paper 3C0226

Particles and Fields—Magnetosphere

5715 Electric Field
PLASMASPHERIC ELECTRIC FIELD AS MEASURED BY ISEE-1
N. C. Maynard (Laboratory for Extraterrestrial Physics, Goddard Space Flight Center, Greenbelt, MD 20771) T. L. Aggson and J. P. Heppner

Data from the double cylindrical probe electric field instrument on ISEE-1 has been analyzed to determine the average characteristics of the plasmaspheric electric field from L of 2 to 6. One year's data has been sorted and averaged covering all local times. The unaveraged electric field is highly variable, especially as magnetic activity increases. Typical magnitudes in the equatorial plane are between 0.2 and 0.8 mV/m in a frame corotating with the Earth. During intense activity the electric fields become larger occasionally exceeding 2mV/m. The average quiet electric fields are qualitatively in agreement with previous whistler and ionospheric radar measurements and also with representative ionospheric dynamo models. Under moderate and distrubed conditions the magnetospheric convection electric field penetrates inside the plasmasphere in the late evening and early morning sectors. A region of significant flow toward the pre-noon magnetopause was detected post-noon, extending around toward dusk. This may be a substorm related effect. The electric field in the pre-noon quadrant was small under most conditions. Conversion of the electric field to flow velocities in the intertial frame shows that the plasma is moving in the direction of corotation at all local times in the inner plasmasphere. In the evening sector the flow velocity is reduced, and in the morning sector it is enhanced as convection penetrates the outer L shells. A mixed behavior is seen in the afternoon hours.
J. Geophys. Res., Blue, Paper 3A0267

5735 Plasma instabilities
A SURVEY OF ELECTROSTATIC WAVES IN SATURN'S MAGNETOSPHERE
W. S. Kurth (Dept. of Physics and Astronomy, University of Iowa, Iowa City, IA 52242), F. L. Scarf, D. A. Gurnett, and D. D. Barbosa

The Voyager 1 and 2 plasma wave instruments have provided initial observations of electrostatic waves in Saturn's magnetosphere. In general the emissions at Saturn are similar to those found at Earth and Jupiter, although there are significant differences in some of the detailed characteristics. In this paper we present an overview of the various types of electrostatic waves in the Saturnian magnetosphere including Langmuir waves and electron cyclotron harmonic emissions. We shall summarize the temporal and spectral character, amplitude and regions of occurrence for the various classes of emissions. These characteristics are compared with those of the terrestrial and Jovian counterparts with the goal of understanding how major differences in the magnetospheric configuration might contribute to the observed differences. Finally, we utilize the theory of electron cyclotron harmonic emissions to try to gain an insight into the electron distributions and possible wave-particle interactions in Saturn's magnetosphere. (Electrostatic waves, Saturn's magnetosphere).
J. Geophys. Res., Blue, Paper 3A0313

5760 Plasma motion, convection, or circulation
DAWN-DUSK ELECTRIC FIELD ASYMMETRY OF THE IO PLASMA TORUS
D.D. Barbosa (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024), M.G. Kivelson

We consider the effects of a combined convection and corotation electric field across the Io plasma torus. A dawn-to-dusk electric field E_c will modify the orbits of charged particles shifting them toward dawn. The radial drift imposed by the perturbed orbits implies a local time-dependent modulation of low-energy ion and electron temperatures with particles hotter at dusk than at dawn. With E_c = 4 mV/m, the orbits near 6 R_J would be shifted by approximately 0.2 R_J. Then the electron temperature would be 20% higher at dusk than at dawn, an effect which could explain the local time asymmetry of EUV intensity found by the Voyager ultraviolet spectrometer. The source of the convection electric field is internal to the magnetosphere and is attributed to the tailward escape of Iogenic and Jovian plasma toward the Alfven surface. (Electric field, Io plasma, ...

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5760 Plasma Motion, Convection or Circulation
NEUTRAL SHEET CURRENT INTERRUPTION AND FIELD-ALIGNED CURRENT GENERATION BY THREE DIMENSIONAL DRIVEN RECONNECTION
Tetsuya Sato (Institute for Fusion Theory, Hiroshima University, Hiroshima 730, Japan), Takaya Hayashi, Raymond J. Walker and Maha Ashour-Abdalla

We have simulated externally driven reconnection by solving the magnetohydrodynamic equations in a three-dimensional, tail-like geometry. As reconnection proceeds, the tail current is interrupted locally and field aligned currents are generated. The field aligned current flows towards the ionosphere on the morning side and away from the ionosphere in the evening. The field-aligned currents flow in a narrow band at the outer edge of the plasma sheet. Thus, the simulation demonstrates that the nightside substorm current system is a natural consequence of the driven reconnection model. (Field aligned currents, magnetic reconnection).
Geophys. Res. Lett., Paper 3L0207

Seismology

6905 Body waves
SPECTRAL CHARACTERISTICS OF HIGH-FREQUENCY P_n, S_n PHASES IN THE WESTERN PACIFIC
D. A. Walker (Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii 96822), C. S. McCreery and G. H. Sutton

Pn and Sn phases from twenty-five selected earthquakes recorded since July of 1979 on ocean bottom hydrophones near Wake Island are used to complement and extend prior investigations of high-frequency Pn,Sn spectra in the Western Pacific. At a distance of about 18° (≃2000 km), frequencies for Pn and Sn are as high as 30 and 35 Hz, respectively; at a distance of about 30° (≃3300 km), as high as 15 and 20 Hz, respectively. Pn phases lose their high-frequency energy more rapidly than Sn phases do, yet Pn wavetrains are much longer than Sn wavetrains. Pn wavetrains of longer duration, more energy, and higher frequencies are found for travel paths primarily in the Northwestern Pacific Basin than for travel paths across the transition zone from the shallow Ontong-Java Plateau to the deep Northwestern Pacific Basin. Sn phases are extremely weak or absent for travel paths crossing this transition zone from the shallower Ontong-Java Plateau to the deeper Northwestern Pacific Basin, whereas Sn phases are well recorded for travel paths crossing the transition zone in the opposite direction. Although normal, mantle-refracted P phases are well recorded beyond about 21° (≃2300 km), available data indicate that detectable normal, mantle-refracted P phases may not exist at distances less than 21°.
J. Geophys. Res., Red, Paper 3B0272

6940 Phenomena related to earthquake prediction
LOCAL SEISMICITY PRECEDING THE MARCH 14, 1979 PETATLAN, MEXICO EARTHQUAKE (Ms=7.6)
Vindell Hsu (Hawaii Institute of Geophysics, University of Hawaii, 2525 Correa Rd., Honolulu, HI

Local seismicity of an area surrounding the epicenter of the March 14, 1979 Petatlan, Mexico, earthquake was monitored by a network of portable seismographs from six weeks before to four weeks after the main shock. Prior to the main shock, the recorded local seismic activity was shallow and restricted above the Benioff Zone. The relocated main shock hypocenter also lay above the Benioff Zone suggesting an initial failure within the continental lithosphere. Four regions can be recognized that showed relatively higher seismic activity than the background. Activity within these zones can be shown to have followed a number of moderate earthquakes that occurred before or after the initial deployment of the network. Three of these moderate earthquakes were near the Mexican coastline and occurred sequentially from southeast to northwest during the three months before the Petatlan earthquake. The Petatlan event occurred along the extension of this trend. We infer a possible connection between this observed earthquake migration pattern and the subduction of the Orozco Fracture Zone. The Petatlan earthquake source region includes the region of the last of the three near-coast seismic activities (Zone A). Earthquakes of Zone A migrated toward the main shock epicenter and were separated from it by an aseismic zone about 10 km wide. These foreshocks have occurred within the continental lithosphere and their observed characteristics are interpreted as due to the high stress environment before the main shock. The pre-main shock seismicity of the Petatlan earthquake source region shows a good spatial correlation with the aftershocks. This suggests that an asperity existing along the Benioff Zone has affected both the pre-main shock activity in the continental lithosphere and the aftershocks along the Benioff Zone. Although major thrust earthquakes at trenches occur along Benioff Zones, in the present study we find little activity on this interplate boundary before the Petatlan earthquake. The overlying continental block, on the contrary, is very active seismically. Our data suggest that the activity is probably governed by the stress transmitted from below due to coupling between two plates and the heterogeneity within the continental lithosphere. The continental material is probably the more likely place for precursors. (Local earthquakes, Foreshocks, Asperity).
J. Geophys. Res., Red, Paper 3B0271

6970 Structure of the Crust and Upper Mantle.
THE INVERSE PROBLEM OF A SPHERICALLY SYMMETRIC FLUID EARTH.
SHIMON COEN (Engineering Geoscience Group, Department of Materials Science and Mineral Engineering, University of California, Berkeley, CA. 94720)

It is shown that the density and velocity profiles of a spherically symmetric fluid earth are uniquely determined from the surface particle acceleration and pressure at two arbitrary frequencies. The excitation is an harmonically oscillating point source which is located on the surface of the earth. An illustrated example shows analytically all the steps in the inversion